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By _____

PATENT

Attorney Docket No.: IMM1P066.RE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re reissue application of:	
Salcudean, *et al.*	Examiner: Unassigned
Serial No.: Unassigned	Art Unit: Unassigned
Filed: Unassigned	**REISSUE DECLARATION UNDER 37 C.F.R. § 1.175(a) AND POWER OF ATTORNEY BY INVENTORS**
For: CONTROLLER	

The Honorable Commissioner of Patents and Trademarks
Washington, D. C. 20231

Sir:

We, Septimiu Edmund Salcudean and Allan J. Kelley, state and declare the following:

1. We are citizens of Canada residing at 4338 West 2nd Avenue, Vancouver, British Columbia, Canada, V6R 1K3 and Unit 147 - 16275 15th Avenue, Surrey, British Columbia, Canada, V4A 1L4, respectively.

2. The entire right, title and interest to U.S. Patent No. 5,790,108, issued August 4, 1998 is vested in Immersion Corp., a California corporation having a regular and established place of business at 2158 Paragon Dr., San Jose, CA 95131.

3. We verily believe ourselves to be the original, first, and joint inventors of the invention described and claimed in the above-identified United States Letters Patent and in the present application for reissue of the above-identified United States Letter Patent.

4. We have reviewed and understand the contents of the attached specification and claims, including the amended and new claims as presented in this application for reissue of the original Letters Patent.

5. We acknowledge the duty to disclose information of which we are aware and which is material to the examination of this application for reissue of the original Letters Patent in accordance with 37 C.F.R. § 1.56, including information which was discovered between the filing date of United States Patent Application Serial No. 07/965,427 that matured into the Letters Patent for which reissue is being sought and the filing date of this application for reissue.

6. We verily believe that the original Letters Patent is partly or wholly inoperative or invalid by reason of our claiming more or less than we had a right to claim in the original Letters Patent, and that the errors described below which render said Letters Patent so partly or wholly inoperative or invalid occurred through inadvertence and/or omission without any fraudulent or deceptive intent on our part.

7. More specifically, we believe that the original Letters Patent for which we seek reissue claims more or less than we had the right to claim for the following reasons:

7.1. Claim 1 of the original Letters Patent recites a controller comprising a base, a platform, and a first and second magnetic force applying means, including first and second magnet means and first and second cooperating magnetic force generating means. The first and second magnetic force generating means are mounted on and moveable with the platform. The specification of the original Letters Patent discloses that the handle of the controller is coupled to the magnetic force generating means via the platform. By failing to recite that the magnetic force generating means is coupled to a handle of the controller, the original Letters Patent claimed less than the applicant had a right to claim. In addition, by failing to recite a support rather than a means for mounting, the original Letters Patent claimed less than the applicant had a right to claim.

7.2. To cure the aforementioned error of the scope of claim 1, we therefore request that claim 1 be amended as presented below:

1. (amended) A controller comprising a base, a handle [platform], [means for mounting said platform for] a support providing said handle with a range of movement in a plane in each of two different directions, a first magnetic force applying means including a first magnet means mounted on said base and a first cooperating magnetic force generating means coupled to said handle [mounted on and moveable with said platform] in position to interact with said first magnet means, a second magnetic force applying means including a second magnet means mounted on said base and a second cooperating magnetic force generating means coupled to said handle [mounted on and moveable with said platform] in a position to interact with said second magnet means, said first and said second magnet means being fixed relative to each other on said base and said first and second cooperating magnet force generating means being fixed relative to each other on said platform, said first force applying means being positioned and constructed to controllably apply selected forces to said handle [platform] in one of said two different directions and said second force applying means being constructed and positioned to controllably apply selected forces to said handle [platform] in the other of said two different directions and control means to selectively control said first and said second force applying means to generate said selected forces.

7.3. The addition of such a claim would cure our aforementioned error of the scope of claim 1 by reciting that the controller comprises a handle, that a support provides the handle with range of movement and that the first and second cooperating magnetic force generating means are coupled to the handle. The particular deleted terms of claim 1 are now understood not to be required to distinguish the invention.

7.4. Amended dependent claims 3-8, 10, 11, 13, and 14 have been changed to include antecedent basis to the term "handle" in independent claim 1 and to remove the term "platform" that was deleted in independent claim 1. The amendments to these claims are listed after this declaration.

7.5. Column 6, lines 50-63 and column 8, lines 29-38 and 47-65 of the original Letters Patent includes what we believe to be an accurate and proper characterization of an interface device including a separate microprocessor for use with a host computer, reproduced below:

An embedded micro-controller 67 (see FIG. 1) may be used for controlling the motion sensing and force actuation of the system. This micro-controller determines the movement of the platform as above described by the interruption of the beam 64 by the line grid. When motion is detected, the micro-controller 67 sends the appropriate information packet through a connection to the computer's mouse port where it is interrupted by that system's mouse driver in the same way as it would for a common mouse.

After calculating the position of the platform 14, the micro-controller's control program also calculates any necessary feedback forces and causes their actuation by turning on current drivers that excite one or both of the x and/or y direction coils 90.

Force feedback is applied to the handle 18, 140, or 168 is generated by programming a computer. For demonstration purposes the configuration shown in FIG. 11 was used wherein a first display station computer 200 was interconnected with a mouse controller 202 by two lines of serial communication 204 and 206 respective specifically a connection to the mouse port for supplying the work station with mouse motion data and a connection from a serial port for receiving commands and screen information from the work station. ...

Preferably the mouse 202 will send movement and button status data to the computer 200 where software calculates the desired forces for that particular pointer location and sends that force information to the micro controller which in turn drives the coils 90, 124 and 156 as required. However, this requires a very high powered computer and therefore to simplify to permit operation with the equipment available the computer 200 responsibilities were limited to handling the usual x window events, process input to maintain graphic interface and to initiate a synchronous transmission of non-real time commands to the micro controller when necessary. The micro controller is given the responsibility of doing the mouse position

sensing to control movement and the transmission of mouse status data to the host mouse port and at the same time respond to commands from the host 200 and store in memory the locations of icon, windows, buttons, etc. that are activated on the display and to interactively calculate the necessary feedback forces with respect to pointer or curser [sic] positions during control movements.

7.6. The absence in the original Letters Patent of an independent claim in which an interface device enables manual interactions with application software running on a host computer, where the device includes a handle, at least one actuator, a support mechanism, a sensor, and a microprocessor separate from the host computer that sends a representation of a sensor signal to the host computer and calculates forces local to the device to be applied by the actuator upon the handle, without the recital of specific elements such as magnetic force applying means, such as is provided in new claim 19 below, resulted in the original Letters Patent claiming less than the applicant had a right to claim. At the time of drafting and prosecution of the application that matured into the original Letters Patent, we did not perceive that such a claim could be made. We recently reviewed the claims of the original Letters Patent and realized that there was an issue that we may have claimed less than we had a right to claim, and we have been consulting with our counsel to determine whether a reissue should be filed to cure this error.

7.7. To cure the aforementioned error of inadvertent omission, we therefore request the addition of a claim such as claim 19 below:

19. A human interface device for enabling manual interactions with application software running on a host computer, said software providing images displayed on a computer display, said device comprising:

(a) a handle to be manipulated manually by a user;

(b) at least one actuator coupled to said handle;

(c) a support mechanism which supports said handle while allowing a plurality of degrees of freedom of said handle with respect to an origin;

(d) a sensor that produces a locative signal responsive to and corresponding with the position of said handle; and

(e) a microprocessor separate from said host computer and coupled to said host computer by a communication bus, said microprocessor also coupled to said sensor and to said actuator,

said microprocessor receiving said locative signal from said sensor and sending a representation thereof over said communication bus to said host computer, said microprocessor calculating, locally to said interface device, forces to be applied by said actuator upon said handle in parallel with said application software running on said host computer, said locally-calculated forces corresponding to the interactions of graphical objects displayed by said host computer.

7.8. The addition of such a claim would cure our error of inadvertent omission by reciting a human interface device that includes a handle, at least one actuator, a sensor, and a microprocessor separate from the host computer, without the inclusion of elements which are not required to distinguish the invention over the prior art. In particular, this claim differs from the independent claim of the present Letters Patent by reciting, among other elements, "a microprocessor separate from said host computer and coupled to said host computer by a communication bus, said microprocessor also coupled to said sensor and to said actuator, said microprocessor receiving said locative signal from said sensor and sending a representation thereof over said communication bus to said host computer, said microprocessor calculating, locally to said device, forces to be applied by said actuator upon said handle," without the inclusion of other elements such as a first and second magnetic force applying means and first and second cooperating magnetic force generating means, which are now understood not to be required to distinguish the invention recited in claim 19.

7.9. New dependent claim 20 would cure the inadvertent omission of a claim which recites a microprocessor which receives force information from the host computer.

7.10. New dependent claim 21 would cure the inadvertent omission of a claim which recites a support mechanism that allows linear displacement between the handle and the origin.

7.11. New dependent claims 22-24 would cure the inadvertent omission of claims which recite features of an optical sensor system including a light source projecting light upon a detector, a light source that moves when the handle is moved, and a detector that detects motion of the light source in two mutually perpendicular directions.

7.12. New dependent claims 25 and 26 would cure the inadvertent omission of claims which recite a switch capable of being in an on state and an off state, where the microprocessor can detect the states of the switch and generate a corresponding signal for receipt by the host computer, and a feature where the switch comprises a button.

7.13. New dependent claims 27 and 28 would cure the inadvertent omission of claims which recite features such as memory that stores values representative of the locations of images displayed by the host computer, and that the locations include the locations of icons displayed by the host computer.

7.14. New dependent claims 29 and 30 would cure the inadvertent omission of claims which recite that the handle is a joystick and that the handle is a mouse.

7.15. New dependent claim 31 would cure the inadvertent omission of a claim which recites that the microprocessor receives display information from the host computer over the communication bus.

7.16. New dependent claims 32-34 would cure the inadvertent omission of claims which recite that the forces include a viscous drag force, that the forces include an attractive force, and that the attractive force is used to assist a user in positioning a displayed cursor into a displayed icon.

7.17. New dependent claims 35 and 36 would cure the inadvertent omission of claims which recite that the forces are correlated with a displayed cursor being drawn over a displayed graphical menu, and that the forces are applied when a boundary region is entered or exited by a displayed cursor.

7.18. New dependent claims 37 and 38 would cure the inadvertent omission of claims which recite that the actuator is a flat coil actuator, and that the magnet

associated with the flat coil actuator is fixed with respect to the origin and the coil moves with respect to the origin.

7.19. New dependent claim 39 would cure the inadvertent omission of a claim which recites that the microprocessor receives code over a communication bus from a host computer and executes the code, where the communication bus includes a serial interface bus.

7.20. New dependent claim 40 would cure the inadvertent omission of a claim which recites that the handle is moveable in a planar, two degree of freedom workspace.

7.21. We further believe that the absence in said Letters Patent of an independent claim in which a device used in conjunction with a host computer, including a handle, a support mechanism, a sensor, a microcontroller running a program in memory in parallel with an application program, and an actuator, claimed without the inclusion of other elements included in claims 1-18 of the original patent, such as is provided in new claim 41 below, is an error of inadvertent omission that occurred during the drafting and prosecution of the application that matured into the present Letters Patent. At the time of drafting and prosecution of the application that matured into the present Letters Patent, we did not perceive that a device that includes the above elements should be claimed independently, without the inclusion of other elements such as are included in claims 1-18 of the present Letters Patent. To cure the aforementioned error of inadvertent omission, we therefore request the addition of a claim such as claim 41 below:

> 41. A device for use in conjunction with a host computer including a computer display, said device comprising:
>
> a handle;
>
> a support mechanism coupled to and supporting said handle while allowing motion of said handle in a plurality of degrees of freedom;
>
> a sensor coupled to at least one of said handle and said support mechanism and that produces a locative signal responsive to and corresponding with a position or motion of said handle;

an embedded microcontroller within a housing of said device and coupled to said sensor such that said microcontroller can read said locative signal from said sensor, said microcontroller running a program contained, at least in part, in memory coupled to said microcontroller;

said microcontroller providing information for use by said host computer running an application program which can provide images on said computer display, said application program providing force information which can be communicated to said microcontroller over a communication bus, wherein said program running on the microcontroller and said application program running on the host computer are running in parallel; and

an actuator coupled to and controlled at least in part by said microcontroller for providing force sensations to said user which correspond with said images displayed on said computer display.

7.22. New dependent claims 42-45 would cure the inadvertent omission of claims which recite that the memory also stores location information which corresponds with image data from a computer display coupled to the host computer, and that the location information includes information relating to the location of an icon on said graphical display, the location information includes information relating to the location of a window on said graphical display, and that the location information includes information relating to the location of a graphical button on said graphical display.

7.23. New dependent claims 46 and 47 would cure the inadvertent omission of claims which recite that the images include a cursor interacting with another object displayed on the computer display, and that the cursor interacts with an icon image displayed on the computer display.

7.24. New dependent claims 48 and 49 would cure the inadvertent omission of claims which recite that the handle is capable of moving in only two degrees of freedom, and that the two degrees of freedom are linear degrees of freedom.

7.25. We further believe that the absence in said Letters Patent of an independent claim reciting a force feedback mouse for use with a host computer, the mouse including a handle, a sensor, an actuator, a microprocessor separate from the

host computer, and a communication bus coupling the microprocessor to the host computer, claimed without the inclusion of other elements included in claims 1-18 of the original patent, such as is provided in new claim 50 below, is an error of inadvertent omission that occurred during the drafting and prosecution of the application that matured into the present Letters Patent. At the time of drafting and prosecution of the application that matured into the present Letters Patent, we did not perceive that a mouse that includes the above elements should be claimed independently, without the inclusion of other elements such as are included in claims 1-18 of the present Letters Patent. To cure the aforementioned error of inadvertent omission, we therefore request the addition of a claim such as claim 50 below:

50. A force feedback mouse for use with a host computer running an application program which displays images on a display apparatus, said mouse enabling a user to control the position of a cursor displayed on said display apparatus and enabling said user to feel tactile sensations in accordance with the position of said cursor, said force feedback mouse comprising:

a handle that can be moved by a user in a plurality of degrees of freedom with respect to an origin;

a sensor that provides position information responsive to and corresponding with a user's manipulation of said handle with respect to said origin;

at least one button that provides state information;

at least one actuator coupled to said handle for applying forces to said handle;

a microprocessor separate from said host computer, coupled to said sensor, to said button, and to said at least one actuator, said microprocessor receiving non-real time commands from said host computer, responding to said commands, and controlling the forces applied by said at least one actuator on said handle; and

a communication bus for coupling said microprocessor to said host computer, said bus being adapted to convey said non-real time commands from said host computer to said microprocessor and to convey data representative of said handle position and said button state to said host computer, wherein said application program is running on said host computer in parallel with said control of forces by said microprocessor.

7.26. New dependent claim 51 would cure the inadvertent omission of a claim which recites that the microprocessor calculates force feedback forces.

7.27. New dependent claims 52-54 would cure the inadvertent omission of claims which recite that the handle is moveable in a plane with respect to said origin, that the handle is also moveable along a z-axis that is approximately perpendicular to said plane, and that the force is applied along the z-axis.

7.28. New dependent claims 55-58 would cure the inadvertent omission of claims which recite that the forces are applied to correspond with a displayed cursor interacting with a displayed menu, and with a displayed button, with a displayed window, and with a displayed icon.

7.29. We further believe that the absence in said Letters Patent of an independent claim reciting an interface device for use with a host computer that commands force feedback sensations, the interface device including a physical object, an actuator, a sensor, a user adjustable switch apparatus, and a microprocessor separate from the host computer which receives non-real time commands from the host, signals from the switch apparatus, and a sensor signal, and which executes a process in parallel with a graphical application on the host, claimed without the inclusion of other elements included in claims 1-18 of the original patent, such as is provided in new claim 59 below, is an error of inadvertent omission that occurred during the drafting and prosecution of the application that matured into the present Letters Patent. At the time of drafting and prosecution of the application that matured into the present Letters Patent, we did not perceive that a device that includes the above elements should be claimed independently, without the inclusion of other elements such as are included in claims 1-18 of the present Letters Patent. To cure the aforementioned error of inadvertent omission, we therefore request the addition of a claim such as claim 59 below:

> 59. An interface device for use with a host computer displaying a graphical application on a display device, said host computer displaying, executing, and updating graphical objects in response to user manipulation of said interface device and commanding force feedback sensations in response

to said user manipulation and in coordination with said graphical objects, the interface device comprising:

a physical object grasped and manipulatable by a user;

at least one actuator coupled to said physical object for receiving a force control signal and imparting motion along at least one degree of freedom of said physical object and in accordance with said force control signal;

a sensor that detects motion of said physical object along said degree of freedom and outputs signals relating to the position of said physical object;

a user-adjustable switch apparatus providing a state signal representing a state of said switch apparatus; and

a microprocessor local to said interface apparatus, separate from said host computer, and coupled to said host computer, to said sensor, and to said switch apparatus, said microprocessor receiving

non-real time commands from said host computer,

said state signal from said switch apparatus, and

said signals from said sensor,

said microprocessor executing a process in parallel with said host execution of said graphical application and providing said force control signal to said at least one actuator in accordance with and corresponding to control movements made by the user which affect said graphical objects displayed by said display device;

said actuator thereby applying force feedback sensations to said physical object.

7.30. New dependent claim 60 would cure the inadvertent omission of a claim which recites that the information sent by the host computer to the microprocessor comprises force information.

7.31. We further believe that the absence in said Letters Patent of an independent claim in which a device used in conjunction with a host computer, including a handle, a support mechanism, a sensor, a microcontroller running a local program in memory in parallel with a host program, and an actuator, claimed without the inclusion of other elements included in claims 1-18 of the original patent, such as is provided in new claim 61 below, is an error of inadvertent omission that occurred during the drafting and prosecution of the application that matured into the present

Letters Patent. At the time of drafting and prosecution of the application that matured into the present Letters Patent, we did not perceive that a device that includes the above elements should be claimed independently, without the inclusion of other elements such as are included in claims 1-18 of the present Letters Patent. To cure the aforementioned error of inadvertent omission, we therefore request the addition of a claim such as claim 61 below:

> 61. A device for use in conjunction with a host computer including a computer display, said device comprising:
>
> a handle;
>
> a support mechanism coupled to and supporting said handle while allowing motion of said handle in a plurality of degrees of freedom;
>
> a sensor coupled to at least one of said handle and said support mechanism and that produces a locative signal responsive to and corresponding with a position or motion of said handle;
>
> an embedded microcontroller within a housing of said device and coupled to said sensor such that said microcontroller can read said locative signal from said sensor, said microcontroller running a local program contained, at least in part, in memory coupled to said microcontroller,
>
> said microcontroller providing sensed information for use by said host computer running a program which can provide images on said computer display, said program providing tactile information which can be communicated to said microcontroller over a communication bus, wherein said local program running on the microcontroller and said program running on the host computer are running in parallel; and
>
> an actuator coupled to and controlled at least in part by said microcontroller for providing tactile sensations to said user which correspond with said images displayed on said computer display.

7.32. New dependent claim 62 would cure the inadvertent omission of claims which recite that the sensed information sent to the host computer includes movement data representative of motion of the handle and button status data representative of a state of at least one button provided on the device.

7.33. We further believe that the absence in said Letters Patent of an independent claim reciting a method for controlling a force feedback interface device

including sending a position signal to a host computer, receiving information from the host computer by a local microprocessor, and outputting a signal from the microprocessor to one or more actuators, claimed without the inclusion of other elements included in claims 1-18 of the original patent, such as is provided in new claim 63 below, is an error of inadvertent omission that occurred during the drafting and prosecution of the application that matured into the present Letters Patent. At the time of drafting and prosecution of the application that matured into the present Letters Patent, we did not perceive that a method that includes the above elements should be claimed independently, without the inclusion of other elements such as are included in claims 1-18 of the present Letters Patent. To cure the aforementioned error of inadvertent omission, we therefore request the addition of a claim such as claim 63 below:

> 63. A method for controlling a force feedback interface device using a host computer, said interface device manipulated by a user, a display device coupled to said host computer displaying a graphical user interface including images and updating said graphical user interface in response to said manipulation of said interface device, said interface device conveying force feedback sensations to said user in response to said manipulations, the method comprising:
>
> sending a position signal to said host computer, said position signal including information representative of the motion or position of a handle of said interface device in a plurality of degrees of freedom with respect to a surface, said handle being grasped by said user, wherein said host computer updates the location of a cursor within said graphical user interface in response to said position signal;
>
> receiving position information from said host computer by a microprocessor local to said force feedback interface device, said microprocessor executing a local process in parallel with said graphical user interface executed by said host computer, said local process calculating force feedback forces with respect to said position information; and
>
> outputting a signal from said microprocessor to one or more actuators, said signal controlling the direction and magnitude of a force to be applied by said one or more actuators on said handle grasped by said user.

7.34. New dependent claim 64 would cure the inadvertent omission of a claim which recites that a sensor signal is input to the microprocessor, the microprocessor calculating the position signal based on the sensor signal, the microprocessor sending the position signal to the host computer.

7.35. New dependent claim 65 would cure the inadvertent omission of a claim which recites that the handle includes a joystick that can be moved by the user in two degrees of freedom.

7.36. New dependent claim 66 would cure the inadvertent omission of a claim which recites that the graphical user interface provides graphical objects for interfacing with an application program running on the host computer, the graphical objects including an icon, a window, and a menu.

7.37. Column 8, lines 66-67 and column 9, lines 1-63 of the original Letters Patent includes what we believe to be an accurate and proper characterization of force feedback associated with elements in a graphical user interface, reproduced below:

> FIG. 12 shows an example of a graphic user interface that could be augmented with tactile and kinesthetic interface using the present invention. The various lettered designations illustrate some of the features that may be obtained using the force feedback of the present invention.
>
> A. The mouse may be programmed to constrain the cursor for movement along a straight edge.
>
> B. indicates a menu bar that may be programmed as kinaesthetically stable place when it is approached from below so that the user can move the pointer rapidly in the direction of the menu bar from below and when it reaches the menu bar force feedback applied to the control handle to stop the motion of the controller and thus of the pointer.
>
> The menu bar itself may be provided with bi-stable tactile elements to indicate when the pointer moves from one menu item to the next.
>
> C. indicates a vertical menu. In this system the mouse could be set to permit the pointer to move only vertically up or down the menu.

D. The scroll bar shown at D may be supplemented with force feedback applied to the arrow used for the scrolling process by allowing the user to move faster and be more carefree when trying to position the pointer over the arrow. This can be done by creating forces at the sides on the arrow that prevent the pointer from overshooting, i.e. it would impede the mouse as it moves across the arrow.

The force feedback system could also be used to actuate the computer rather than the button or switch mounted on the handle EG. switch 20. The mouse would simulate a button press in its transmission to the computer whenever the force with which the user pushes against one of the sides of the arrow exceeds a threshold.

E. shows a thumb type scroll bar which is similar to the arrow type scroll bar and to which force feedback could be applied to form a stable position in the bar and prevent the pointer from overshooting and constrain the pointer from going beyond the thumb opening. After the pointer is in position within the thumb opening pressing the pointer against the top or bottom of the thumb opening, the thumb would follow the motion of the pointer.

Furthermore, as the thumb is moved a damping force could be added and the motion direction, giving the user feedback in the form of a viscous drag sensation and when the thumb has reached the limit of its range appropriate force could be applied to the handle.

F. Command Soft button manipulatable by movement of the pointer or curse [sic] to initiate command i.e. soft buttons that may be pressed by the pointer and the tactile sense of pressing a button transferred back to the controller handle so that the feel of pressing a button.

G. shows further examples of soft buttons that could be used in a manner similar to icons and incorporate in the software a force gravitational scheme to facilitate user arriving at the button.

H. shows tactile regions wherein examples of specific tools may be selected[.] The use of a bi-stable tactile feedback system could be employed to make user selection of the desired tool more quick and accurate.

I. indicates a system wherein gravitational force may be applied to draw the cursor pointer to the icon when it comes within a certain preselected distance of the icon.

J. demonstrates a window boundary wherein force feedback would be designed to prevent the pointer or cursor from traversing such a boundary or apply force when the window is entered or exited.

7.38. We further believe that the absence in said Letters Patent of an independent claim reciting a method for providing force feedback to a user of a force feedback interface device, including receiving a locative signal on a local microprocessor, associating elements in a graphical user interface with forces affecting the handle based on a location of a cursor, and providing a signal to an actuator to apply force to the handle to impede or direct motion of the handle, claimed without the inclusion of other elements included in claims 1-18 of the original patent, such as is provided in new claim 67 below, is an error of inadvertent omission that occurred during the drafting and prosecution of the application that matured into the present Letters Patent. At the time of drafting and prosecution of the application that matured into the present Letters Patent, we did not perceive that a method that includes the above elements should be claimed independently, without the inclusion of other elements such as are included in claims 1-18 of the present Letters Patent. To cure the aforementioned error of inadvertent omission, we therefore request the addition of a claim such as claim 67 below:

67. A method for providing force feedback to a user of a force feedback interface device and of a graphical user interface displayed by a host computer, comprising:

receiving on a microprocessor local to said interface device a locative signal representing a position of a handle in one or more degrees of freedom, said locative signal being used to determine a location of a user-controlled cursor within a graphical user interface displayed on a display device coupled to said host computer, said cursor being controlled by said user by manipulating said handle of said interface device;

associating elements in said graphical user interface with forces affecting said handle based on said location of said user-controlled cursor with respect to said elements;

receiving from said host computer the location of at least one element displayed by said display device and storing said location in memory local to said microprocessor; and

providing a signal to one or more actuators to apply a force on said handle in at least one degree of freedom to impede or direct motion of said handle in said degree of freedom, said force being applied when said cursor interacts with at least one element in said graphical user interface.

7.39. New dependent claims 68-69 would cure the inadvertent omission of claims which recite that element is an icon, and the force is an attractive force that assists the user in positioning the cursor on the icon, and that the force is an impeding force which impedes the user from moving the cursor off of the icon.

7.40. New dependent claim 70 would cure the inadvertent omission of a claim which recites that the element is a vertical menu including a plurality of menu items.

7.41. We believe that the absence in said Letters Patent of an independent claim reciting a method for providing force feedback to a user, including receiving an indication of movement of a physical object, moving a cursor within a graphical user interface, and using an actuator to apply a force to the physical object when the cursor is a preselected distance from a graphical object, claimed without the inclusion of other elements included in claims 1-18 of the original patent, such as is provided in new claim 71 below, is an error of inadvertent omission that occurred during the drafting and prosecution of the application that matured into the present Letters Patent. At the time of drafting and prosecution of the application that matured into the present Letters Patent, we did not perceive that a method that includes the above elements should be claimed independently, without the inclusion of other elements such as are included in claims 1-18 of the present Letters Patent. To cure the aforementioned error of inadvertent omission, we therefore request the addition of a claim such as claim 71 below:

71. A method for providing force feedback to a user interacting with a graphical user interface environment of a computer system, the method comprising:

receiving an indication of movement of a physical object that is manipulated by a user, said physical object being included in a human interface device that outputs said indication to said computer system;

moving a cursor within a graphical user interface, said movement based on said indication of movement of said physical object, wherein said cursor and said graphical user interface are displayed on a display screen coupled to said computer system; and

using an actuator to apply a force in a degree of freedom of motion of said physical object, wherein said force is associated with said interaction of said cursor with said graphical user interface, said force being applied when said cursor is positioned within a preselected distance of a graphical object displayed in said graphical user interface.

7.42. New dependent claim 72 would cure the inadvertent omission of a claim which recites that the graphical object is an icon and that the force applied to the physical object is an attractive force that draws the cursor towards an icon within the graphical user interface when the cursor is substantially adjacent to the icon.

7.43. New dependent claim 73 would cure the inadvertent omission of a claim which recites that the force applied to the physical object acts to resist overshoot of the cursor when the user selects the graphical object.

7.44. New dependent claims 74 and 75 would cure the inadvertent omission of claims which recite that the force is a viscous drag force that is applied when the graphical object is moved, and that the graphical object being moved is the thumb of a scroll bar.

7.45. We hereby appoint the following attorneys and agents to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

James R. Riegel, Reg. No. 36,651; Paul L. Hickman, Reg. No. 28,516; L. Keith Stevens, Reg. No. 32,632; Brian R. Coleman, Reg. No. 39,145; Dawn L. Palmer, Reg. No. 41,238; Jerry Wei, Reg. No. 43,247; Ian L. Cartier, Reg. No. 38,406; and Robert D. Hayden, Reg. No. 42,645.

8. Please send all correspondence to:

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9. We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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AMENDED ORIGINAL CLAIMS

1. (amended) A controller comprising a base, a handle [platform], [means for mounting said platform for] a support providing said handle with a range of movement in a plane in each of two different directions, a first magnetic force applying means including a first magnet means mounted on said base and a first cooperating magnetic force generating means coupled to said handle [mounted on and moveable with said platform] in position to interact with said first magnet means, a second magnetic force applying means including a second magnet means mounted on said base and a second cooperating magnetic force generating means coupled to said handle [mounted on and moveable with said platform] in a position to interact with said second magnet means, said first and said second magnet means being fixed relative to each other on said base and said first and second cooperating magnet force generating means being fixed relative to each other on said platform, said first force applying means being positioned and constructed to controllably apply selected forces to said handle [platform] in one of said two different directions and said second force applying means being constructed and positioned to controllably apply selected forces to said handle [platform] in the other of said two different directions and control means to selectively control said first and said second force applying means to generate said selected forces.

3. (amended) A controller as defined in claim 1 further comprising a sensor means for sensing the position of said handle [platform] relative to said base.

4. (amended) A controller as defined in claim 3 wherein said sensor means comprises a transparent grid coupled to said handle [mounted on and moveable with said platform] and a light source and a detector means fixed relative to said base in positions wherein light from said source passes through said grid and is detected by said detector means.

5. (amended) A controller as defined in claim 2 further comprising a sensor means for sensing the position of said handle [platform] relative to said base.

6. (amended) A controller as defined in claim 5 wherein said sensor means comprises a transparent grid coupled to said handle [mounted on and moveable with said platform] and a light source and a detector means fixed relative to said base in

positions wherein light from said source passes through said grid and is detected by said detector means.

7. (amended) A controller as defined in claim 2 wherein said first cooperating magnet force generating means including a first coil means position to interact with said first magnet means when a current is applied to said first coil means, and said second magnetic force generating means including a second cooperating coil means in a position to interact with said second magnet means when a current is applied to said second coil means, said first magnet means and said first cooperating coil means of said first force applying means being shaped and positioned so that in any position of said handle [platform] within said range said coil may be controlled to apply said selected forces between each of said first and second cooperating coil means and its respective magnet means and wherein said control means selectively applies current to said first and said second cooperating coil means to generate said selected forces.

8. (amended) A controller as defined in claim 7 wherein the projected area of a field generated by said first magnet means onto said first cooperating coil means is substantially constant so that the application of a selected current to said first cooperating coil means generates the same force between said first magnet means and said first cooperating coil means regardless of the position of said handle [platform] within said range of movement, said second magnet means and said second cooperating coil means of said second force applying means being shaped and positioned so that in any position of said handle [platform] within said range the projected area of a field generated by said second magnet means onto said second cooperating coil means is substantially constant so that the application of a selected current to said second cooperating coil means generates the same force between said second magnet means and said second cooperating coil means regardless of the position of said handle [platform] within said range.

10. (amended) A controller as defined in claim 5 wherein said first cooperating magnet force generating means including a first coil means position to interact with said first magnet means when a current is applied to said first coil means, and said second magnetic force generating means including a second cooperating coil means in a position to interact with said second magnet means when a current is applied to said second coil means, said first magnet means and said first cooperating coil means of said first force applying means being shaped and positioned so that in any position of said handle [platform] within said range said coil may be controlled to apply said selected forces between each of said first and second

cooperating coil means and its respective magnet means and wherein said control means selectively applies current to said first and second cooperating coil means to generate said selected forces.

11. (amended) A controller as defined in claim 10 wherein the projected area of a field generated by said first magnet means onto said first cooperating coil means is substantially constant so that the application of a selected current to said first cooperating coil means generates the same force between said first magnet means and said first cooperating coil means regardless of the position of said handle [platform] within said range of movement, said second magnet means and said second cooperating coil means of said second force applying means being shaped and positioned so that in any position of said platform within said range the projected area of a field generated by said second magnet means onto said second cooperating coil means is substantially constant so that the application of a selected current to said second cooperating coil means generates the same force between said second magnet means and said second cooperating coil means regardless of the position of said handle [platform] within said range.

13. (amended) A controller as defined in claim 6 wherein said first cooperating magnet force generating means including a first coil means position to interact with said first magnet means when a current is applied to said first coil means, and said second magnetic force generating means including a second cooperating coil means in a position to interact with said second magnet means when a current is applied to said second coil means, said first magnet means and said first cooperating coil means of said first force applying means being shaped and positioned so that in any position of said [platform] handle within said range said coil may be controlled to apply said selected forces between each of said first and second cooperating coil means and its respective magnet means and wherein said control means selectively applies current to said first and said second cooperating coil means to generate said selected forces.

14. (amended) A controller as defined in claim 13 wherein the projected area of a field generated by said first magnet means onto said first cooperating coil means is substantially constant so that the application of a selected current to said first cooperating coil means generates the same force between said first magnet means and said first cooperating coil means regardless of the position of said [platform] handle within said range of movement, said second magnet means and said second cooperating coil means of said second force applying means being shaped and

positioned so that in any position of said [platform] handle within said range the projected area of a field generated by said second magnet means onto said second cooperating coil means is substantially constant so that the application of a selected current to said second cooperating means generates the same force between said second magnet means and said second cooperating coil means regardless of the position of said [platform] handle within said range.

NEW CLAIMS

19. A human interface device for enabling manual interactions with application software running on a host computer, said software providing images displayed on a computer display, said device comprising:

(a) a handle to be manipulated manually by a user;

(b) at least one actuator coupled to said handle;

(c) a support mechanism which supports said handle while allowing a plurality of degrees of freedom of said handle with respect to an origin;

(d) a sensor that produces a locative signal responsive to and corresponding with the position of said handle; and

(e) a microprocessor separate from said host computer and coupled to said host computer by a communication bus, said microprocessor also coupled to said sensor and to said actuator,

said microprocessor receiving said locative signal from said sensor and sending a representation thereof over said communication bus to said host computer, said microprocessor calculating, locally to said interface device, forces to be applied by said actuator upon said handle in parallel with said application software running on said host computer, said locally-calculated forces corresponding to the interactions of graphical objects displayed by said host computer.

20. A device as recited in claim 19 wherein said microprocessor receives force information from the host computer.

21. A device as recited in claim 19 wherein said support mechanism allows linear displacement between said handle and said origin.

22. A device as recited in claim 19 wherein said sensor is an optical sensor system that includes a light source that moves relative to a detector when said handle is moved, said light source projecting light upon said detector.

23. A device as recited in claim 22 wherein said sensor is an optical sensor system that includes a light source that moves when said handle is moved, projecting light upon a detector that is fixed with respect to said origin.

24. A device as recited in claim 23 wherein said detector detects motion of said light source in two mutually perpendicular directions.

25. A device as recited in claim 19 further comprising:

a switch capable of being in an on state and an off state, said switch being coupled to said microprocessor such that said microprocessor can detect said states of said switch and generate a corresponding signal for receipt by said host computer.

26. A device as recited in claim 25 wherein said switch comprises a button.

27. A device as recited in claim 19 wherein said memory also stores values that are representative of the locations of images displayed by said host computer.

28. A device as recited in claim 27 wherein said locations include the locations of icons displayed by said host computer.

29. A device as recited in claim 19 wherein said handle is a joystick.

30. A device as recited in claim 19 wherein said handle is a mouse.

31. A device as recited in claim 19 wherein said microprocessor receives display information from said host computer over said communication bus.

32. A device as recited in claim 19 wherein said forces include a viscous drag force.

33. A device as recited in claim 19 wherein said forces include an attractive force.

34. A device as recited in claim 33 wherein said attractive force is used to assist a user in positioning a displayed cursor into a displayed icon.

35. A device as recited in claim 19 wherein said forces are correlated with a displayed cursor being drawn over a displayed graphical menu.

36. A device as recited in claim 19 wherein said forces are applied when a boundary region is entered or exited by a displayed cursor.

37. A device as recited in claim 19 wherein said at least one actuator is a flat coil actuator.

38. A device as recited in claim 37 wherein the magnet associated with said at least one flat coil actuator is fixed with respect to said origin and wherein the coil moves with respect to said origin.

39. A device as recited in claim 19 wherein said microprocessor receives code over a communication bus from a host computer and executes said code, said communication bus including a serial interface bus.

40. A device as recited in claim 19 wherein said handle is moveable in a planar, two degree of freedom workspace.

41. A device for use in conjunction with a host computer including a computer display, said device comprising:

a handle;

a support mechanism coupled to and supporting said handle while allowing motion of said handle in a plurality of degrees of freedom;

a sensor coupled to at least one of said handle and said support mechanism and that produces a locative signal responsive to and corresponding with a position or motion of said handle;

an embedded microcontroller within a housing of said device and coupled to said sensor such that said microcontroller can read said locative signal from said sensor, said microcontroller running a program contained, at least in part, in memory coupled to said microcontroller,

said microcontroller providing information for use by said host computer running an application program which can provide images on said computer display,

said application program providing force information which can be communicated to said microcontroller over a communication bus, wherein said program running on the microcontroller and said application program running on the host computer are running in parallel; and

an actuator coupled to and controlled at least in part by said microcontroller for providing force sensations to said user which correspond with said images displayed on said computer display.

42. A device as recited in claim 41 wherein said memory also stores location information which corresponds with image data from a computer display coupled to said host computer.

43. A device as recited in claim 42 wherein said location information includes information relating to the location of an icon on said graphical display.

44. A device as recited in claim 42 wherein said location information includes information relating to the location of a window on said graphical display.

45. A device as recited in claim 42 wherein said location information includes information relating to the location of a graphical button on said graphical display.

46. A device as recited in claim 42 wherein said images include a cursor interacting with another object displayed on said computer display.

47. A device as recited in claim 46 wherein said cursor interacts with an icon image displayed on said computer display.

48. A device as recited in claim 42 wherein said handle is capable of moving in only two degrees of freedom.

49. A device as recited in claim 48 wherein said two degrees of freedom are linear degrees of freedom.

50. A force feedback mouse for use with a host computer running an application program which displays images on a display apparatus, said mouse enabling a user to control the position of a cursor displayed on said display apparatus

and enabling said user to feel tactile sensations in accordance with the position of said cursor, said force feedback mouse comprising:

a handle that can be moved by a user in a plurality of degrees of freedom with respect to an origin;

a sensor that provides position information responsive to and corresponding with a user's manipulation of said handle with respect to said origin;

at least one button that provides state information;

at least one actuator coupled to said handle for applying forces to said handle;

a microprocessor separate from said host computer, coupled to said sensor, to said button, and to said at least one actuator, said microprocessor receiving non-real time commands from said host computer, responding to said commands, and controlling the forces applied by said at least one actuator on said handle; and

a communication bus for coupling said microprocessor to said host computer, said bus being adapted to convey said non-real time commands from said host computer to said microprocessor and to convey data representative of said handle position and said button state to said host computer, wherein said application program is running on said host computer in parallel with said control of forces by said microprocessor.

51. A force feedback mouse as recited in claim 50 wherein said microprocessor calculates force feedback forces.

52. A force feedback mouse as recited in claim 50 wherein said handle is moveable in a plane with respect to said origin.

53. A force feedback mouse as recited in claim 52 wherein said handle is also moveable along a z-axis that is approximately perpendicular to said plane.

54. A force feedback mouse as recited in claim 53 wherein said force is applied along said z-axis.

55. A force feedback mouse as recited in claim 50 wherein said forces are applied to correspond with a displayed cursor interacting with a displayed menu.

56. A force feedback mouse as recited in claim 50 wherein said forces are applied to correspond with a displayed cursor interacting with a displayed button.

57. A force feedback mouse as recited in claim 50 wherein said forces are applied to correspond with a displayed cursor interacting with a displayed window.

58. A force feedback mouse as recited in claim 50 wherein said forces are applied to correspond with a displayed cursor interacting with a displayed icon.

59. An interface device for use with a host computer displaying a graphical application on a display device, said host computer displaying, executing, and updating graphical objects in response to user manipulation of said interface device and commanding force feedback sensations in response to said user manipulation and in coordination with said graphical objects, the interface device comprising:

a physical object grasped and manipulatable by a user;

at least one actuator coupled to said physical object for receiving a force control signal and imparting motion along at least one degree of freedom of said physical object and in accordance with said force control signal;

a sensor that detects motion of said physical object along said degree of freedom and outputs signals relating to the position of said physical object;

a user-adjustable switch apparatus providing a state signal representing a state of said switch apparatus; and

a microprocessor local to said interface apparatus, separate from said host computer, and coupled to said host computer, to said sensor, and to said switch apparatus, said microprocessor receiving

non-real time commands from said host computer,

said state signal from said switch apparatus, and

said signals from said sensor,

said microprocessor executing a process in parallel with said host execution of said graphical application and providing said force control signal to said at least one actuator in accordance with and corresponding to control movements made by the user which affect said graphical objects displayed by said display device;

said actuator thereby applying force feedback sensations to said physical object.

60. The interface device claimed in claim 59 wherein the information sent by said host computer to said microprocessor comprises force information.

61. A device for use in conjunction with a host computer including a computer display, said device comprising:

a handle;

a support mechanism coupled to and supporting said handle while allowing motion of said handle in a plurality of degrees of freedom;

a sensor coupled to at least one of said handle and said support mechanism and that produces a locative signal responsive to and corresponding with a position or motion of said handle;

an embedded microcontroller within a housing of said device and coupled to said sensor such that said microcontroller can read said locative signal from said sensor, said microcontroller running a local program contained, at least in part, in memory coupled to said microcontroller,

said microcontroller providing sensed information for use by said host computer running a program which can provide images on said computer display, said program providing tactile information which can be communicated to said microcontroller over a communication bus, wherein said local program running on the microcontroller and said program running on the host computer are running in parallel; and

an actuator coupled to and controlled at least in part by said microcontroller for providing tactile sensations to said user which correspond with said images displayed on said computer display.

62. A device as recited in claim 61 wherein said sensed information sent to said host computer includes movement data representative of motion of said handle and button status data representative of a state of at least one button provided on said device.

63. A method for controlling a force feedback interface device using a host computer, said interface device manipulated by a user, a display device coupled to said host computer displaying a graphical user interface including images and updating said graphical user interface in response to said manipulation of said interface device, said interface device conveying force feedback sensations to said user in response to said manipulations, the method comprising:

sending a position signal to said host computer, said position signal including information representative of the motion or position of a handle of said interface device in a plurality of degrees of freedom with respect to a surface, said handle being grasped by said user, wherein said host computer updates the location of a cursor within said graphical user interface in response to said position signal;

receiving position information from said host computer by a microprocessor local to said force feedback interface device, said microprocessor executing a local process in parallel with said graphical user interface executed by said host computer, said local process calculating force feedback forces with respect to said position information; and

outputting a signal from said microprocessor to one or more actuators, said signal controlling the direction and magnitude of a force to be applied by said one or more actuators on said handle grasped by said user.

64. A method as recited in claim 63 wherein a sensor signal is input to said microprocessor, said microprocessor calculating said position signal based on said sensor signal, said microprocessor sending said position signal to said host computer.

65. A method as recited in claim 63 wherein said handle includes a joystick that can be moved by said user in two degrees of freedom.

66. A method as recited in claim 64 wherein said graphical user interface provides graphical objects for interfacing with an application program running on said host computer, said graphical objects including an icon, a window, and a menu.

67. A method for providing force feedback to a user of a force feedback interface device and of a graphical user interface displayed by a host computer, comprising:

receiving on a microprocessor local to said interface device a locative signal representing a position of a handle in one or more degrees of freedom, said locative signal being used to determine a location of a user-controlled cursor within a graphical user interface displayed on a display device coupled to said host computer, said cursor being controlled by said user by manipulating said handle of said interface device;

associating elements in said graphical user interface with forces affecting said handle based on said location of said user-controlled cursor with respect to said elements;

receiving from said host computer the location of at least one element displayed by said display device and storing said location in memory local to said microprocessor; and

providing a signal to one or more actuators to apply a force on said handle in at least one degree of freedom to impede or direct motion of said handle in said degree of freedom, said force being applied when said cursor interacts with at least one element in said graphical user interface.

68. A method as recited in claim 67 wherein said element is an icon, and wherein said force is an attractive force that assists said user in positioning said cursor on said icon.

69. A method as recited in claim 67 wherein said element is an icon, and wherein said force is an impeding force which impedes said user from moving said cursor off of said icon.

70. A method as recited in claim 68 wherein said element is a vertical menu including a plurality of menu items.

71. A method for providing force feedback to a user interacting with a graphical user interface environment of a computer system, the method comprising:

receiving an indication of movement of a physical object that is manipulated by a user, said physical object being included in a human interface device that outputs said indication to said computer system;

moving a cursor within a graphical user interface, said movement based on said indication of movement of said physical object, wherein said cursor and said graphical user interface are displayed on a display screen coupled to said computer system; and

using an actuator to apply a force in a degree of freedom of motion of said physical object, wherein said force is associated with said interaction of said cursor with said graphical user interface, said force being applied when said cursor is positioned within a preselected distance of a graphical object displayed in said graphical user interface.

72. A method as recited in claim 71 wherein said graphical object is an icon and wherein a force applied to said physical object is an attractive force that draws the cursor towards said icon when said cursor is substantially adjacent to said icon.

73. A method as recited in claim 71 wherein said force is applied to said physical object to resist overshoot of said cursor when the user selects said graphical object.

74. A method as recited in claim 71 wherein said force includes a viscous drag force that is applied when said graphical object is moved.

75. A method as recited in claim 74 wherein said graphical object being moved is the thumb of a scroll bar.